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**Clustering of Vortex Wakes for Heaving-Pitching Foils Using Machine Learning** MUKUL DAVE, ALEJANDRO GONZALEZ CALVET, JENNIFER FRANCK, University of Wisconsin-Madison — A heaving-pitching foil produces different vortex patterns that are associated with propulsive regimes of high efficiency or high thrust, however there are many intermediate modes not readily classified due to a chaotic wake structure. Hence, machine learning techniques can be applied to help cluster wake patterns and the associated performance. To evaluate the effectiveness of machine learning, a database of Reynolds-averaged Navier-Stokes simulations at Reynolds number of $10^6$ and high heave amplitudes is utilized. The data includes sweeps in flapping frequency and pitch amplitude to produce a wide range of kinematics and propulsive modes. A convolutional autoencoder with lasso regularization was used to extract a latent space of important features from vorticity images of the wakes. Applying different clustering algorithms to the latent space groups the data into distinct flow regimes, such as a low vorticity regime with minimal flow separation and a high vorticity regime with a reverse von Kárman wake. The results are validated against a pre-labeled subset of samples to explore ways of improving the clustering. To correlate wake clustering with performance, support vector regression was used to predict the values of efficiency, power and thrust based on the kinematics.

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